PATENT APPLICATION

IN THE U.S. PATENT AND TRADEMARK OFFICE

November 23, 2009

Applicants: Hideo SANO et al

For: METHOD OF MANUFACTURING HIGH-STRENGTH ALUMINUM ALLOY EXTRUDED PRODUCT EXCELLING IN CORROSION RESISTANCE AND STRESS CORROSION CRACKING RESISTANCE

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Commissioner for Patents
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APPELLANTS' BRIEF ON APPEAL

Sir:

This is an appeal from the decision of the Examiner dated February 17, 2009, finally rejecting Claims 1 and 4-13.

REAL PARTY IN INTEREST

Sumitomo Light Metal Industries, Ltd. is the assignee of the present application and the real party in interest.

RELATED APPEALS AND INTERFERENCES

There are no related appeals and interferences with the present application.

STATUS OF CLAIMS

Claims 1 and 4-13 are pending and are the claims on review on appeal. Claims 2 and 3 have been canceled.

STATUS OF AMENDMENTS

An Amendment After Final Rejection has not been filed in the present application.

SUMMARY OF CLAIMED SUBJECT MATTER

Appellants' invention, as defined by independent Claim 1, is directed to a method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance (specification page 5, lines 13-16). The method comprises the steps of continuously extruding a billet (numeral 9 in Figure 1) of an aluminum alloy (specification page 11, lines 4-8) comprising 0.5 to 1.5% of silicon, 0.9 to 1.6% of magnesium (specification page 5, line 19), 1.7 to 2.5% of copper (Alloy E in Table 1 of the specification and specification page 5, lines 19 and 20), while satisfying the equations (1), (2), (3) and (4),

$$3 \leq Si\% + Mg\% + Cu\% \leq 4 \qquad (1)$$

$$Mg\% \leq 1.7 \times Si\% \qquad (2)$$

$$Mg\% + Si\% \leq 2.7 \qquad (3)$$

$$Cu\%/2 \leq Mg\% \leq (Cu\%/2) + 0.6 \qquad (4)$$

and further comprising 0.5 to 1.2% of manganese with the balance being aluminum and unavoidable impurities, into a solid product by using a solid die (numeral 1 in Figure 1) having a bearing length (L) of 0.5 mm or more and the bearing length (L) and a thickness (T) of the solid product to be extruded have a relationship defined by L ≤ 5T to obtain a solid product in which a fibrous structure accounts for 60% or more in area-fraction of the cross-sectional structure of the solid product (specification page 5, line 20 through specification page 6, line 6), wherein a flow guide (numeral 4 in Figure 1) is provided in front of the solid die, an inner circumferential surface (numeral 6 in Figure 1) of a guide hole (numeral 5 in Figure 1) of the flow guide is separated from an outer circumferential surface of an orifice (numeral 3 in Figure 1) which is continuous with the bearing of the solid

die at a distance of 5 to 15 mm (specification page 6, lines 7-13 and specification page 20, Example 1, lines 12-16), and the thickness of the flow guide is 5-25% of the diameter of the billet (specification page 6, lines 14 and 15).

Appellants' invention, as defined by independent Claim 6, is directed to a method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance which comprises the steps of extruding a billet (numeral 9 in Figure 1) of an aluminum alloy comprising 0.5-1.5% of silicon, 0.9-1.6% of magnesium (specification page 5, lines 13-19), 1.7-2.5% copper (Alloy E in Table 1 of the specification and specification page 5, lines 19 and 20), while satisfying equations (1)-(4),

$$3 \leq Si\% + Mg\% + Cu\% \leq 4 \qquad (1)$$

$$Mg\% \leq 1.7 \times Si\% \qquad (2)$$

$$Mg\% + Si\% \leq 2.7 \qquad (3)$$

$$Cu\%/2 \leq Mg\% \leq (Cu\%/2) + 0.6 \qquad (4)$$

and further comprising 0.5-1.2% manganese, with the balance being aluminum and unavoidable impurities, into a hollow product (specification page 6, lines 16-20, by using a porthole die or a bridge die (specification page 14, lines 1-4 and Figures 3-6) in which the ratio of the flow speed of the aluminum alloy in a non-joining section (numeral 14 in Figures 3, 5 and 6 and specification page 14, lines 16-18) to the flow speed of the aluminum alloy in a joining section in a chamber (specification page 14, lines 18-20 and numeral 17 in Figures 4-6), where the billet reunites after entering a port section of the die (numeral 12 in Figures 3, 5 and 6) in divided flows and subsequently encircling a mandrel (specification page 14, lines 19 and 20 and numeral 15 in Figures 3, 5 and 6), is controlled at 1.5 or less (specification page 15, lines 27 and 28 and specification page 16, line 1) to obtain a hollow product in which a fibrous structure accounts for 60% or more in area-fraction of the cross-sectional structure of the

hollow product (specification page 16, lines 3-6 and originally presented Claim 3, lines 8-13).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The first ground of rejection to be reviewed on appeal is whether Claims 1 and 4-13 are unpatentable under 35 USC 103(a) over JP 04-000353A (JP '353) in view of JP 2002-317255 (JP '255).

The second ground of rejection to be reviewed on appeal is whether Claim 6 is unpatentable under 35 USC 103(a) over JP 04-000353A (JP '353) in view of JP 2002-317255 (JP '255) and further in view of JP 07-041897 (JP '897).

ARGUMENT

The presently claimed invention is directed to a method for manufacturing a high-strength aluminum alloy extruded product which has excellent corrosion and stress corrosion cracking resistance. The presently claimed method requires a step of continuously extruding a billet of an aluminum alloy comprising, in weight percent, 0.5-1.5% silicon, 0.9-1.6% magnesium, 1.7-2.5% copper and it is required that the following four specified relationships among copper, magnesium and silicon are satisfied,

$$3 \leq Si\% + Mg\% + Cu\% \leq 4 \quad (1)$$

$$Mg\% \leq 1.7 \times Si\% \quad (2)$$

$$Mg\% + Si\% \leq 2.7 \quad (3)$$

$$Cu\%/2 \leq Mg\% \leq (Cu\%/2) + 0.6 \quad (4)$$

, and the alloy further comprises 0.5-1.2% manganese, with the balance being aluminum and unavoidable impurities, into a solid product by using a solid die having a bearing length of 0.5 or more and the bearing length and thickness of the solid product to be extruded have a relationship of the bearing length being ≤ 5 times the thickness of the solid product to be extruded so that the solid product has a fibrous structure which accounts for 60% or more in area fraction of the cross-sectional structure of the solid product. The present

invention requires that a flow guide be provided in front of the solid die, an inner circumferential surface of the guide hole of the flow die be separated from an outer circumferential surface of an orifice which is continuous with the bearing of the solid die at a distance of 9-15 mm and the thickness of the flow guide is 5-25% of the diameter of the billet.

In a second embodiment of the present invention, a high-strength aluminum alloy extruded hollow product having excellent corrosion resistance and stress corrosion cracking resistance is produced by extruding a billet of the above-described aluminum alloy into a hollow product by using a porthole or a bridge die and controlling the ratio of the flow speed of the aluminum alloy in a non-joining section to the flow speed of the aluminum alloy in a joining section in a chamber, where the billet reunites after entering a port section of the die in divided flows and subsequently encircling a mandrel, to 1.5 or less to produce the hollow product having a fibrous structure accounting for 60% or more in area-fraction of the cross-sectional structure of the hollow product.

With the presently claimed methods, an aluminum alloy extruded product having a fibrous structure which accounts for at least 60% or more in area fraction of the cross-sectional structure of the product is provided. In order to have the high-strength aluminum alloy extruded product of the present invention having a fibrous structure accounting for at least 60% in area-fraction of the cross-sectional structure of the product, it is necessary to have the claimed composition used to form the extruded product and the dimensions of the die, as well as various parts of flow guides, applicable when a product is extruded using a die alone or using a die together with a flow guide attached thereto, in order to achieve the extruded product of the present invention having the claimed fibrous structure. It is respectfully submitted that the

prior art cited by the Examiner does not disclose the presently claimed invention.

REJECTION OF CLAIMS 1 AND 4-13
UNDER 35 USC 103(a) AS BEING UNPATENTABLE
OVER JP '353 IN VIEW OF JP '255

JP '353 discloses a method of increasing the strength of a worked product by subjecting an ingot of an aluminum-copper alloy containing 1.5-6 wt.% copper, 0.1-1.5 wt.% manganese, 0.2-2 wt.% magnesium, 0.1-1.5 wt.% silicon, 0.1-0.5 wt.% iron, 0.1-0.3 wt.% (chromium plus zirconium), 0.001-0.2 wt.% titanium or 0.001-0.04 wt.% boron, and the balance being aluminum, to semicontinuous casting to form the ingot. The ingot is heated to a specified temperature range at a specified rate of temperature increase, held at the specified temperature for a specified time period, heated to a second specified temperature range, held at this second specified temperature for a specified time period and then cooled to a specified temperature at a specified cooling rate. JP '353 discloses that by this method, the extinction of a fibrous structure attendant on the progress of recrystallization after aging treatment of an expanded aluminum-copper based aluminum alloy material can be inhibited.

While JP '353 is concerned with providing an aluminum-copper alloy extruded product with a high strength, the present invention is concerned with providing an aluminum-copper-magnesium-silicon alloy extruded product with both a high strength and high corrosion resistance. JP '353 requires that the aluminum-copper alloy have a copper content as high as 4.5% in order to give it its high strength. The present invention gives the aluminum-copper-magnesium-silicon alloy a high strength through its method of preparation utilizing the apparatus limitations of the flow guide being provided in front of the solid die, inner circumferential surface of a guide hole of the flow guide being separated from an outer circumferential surface of an orifice which is continuous with

a bearing of the solid die at a distance of 9-15 mm and the thickness of the flow guide being 5-25% of the diameter of the billet.

JP '353 does not disclose a specific alloy composition falling within the scope of the present claims and also does not disclose the claimed apparatus limitations. As stated above and will be argued further below, it is essential in achieving the claimed high-strength aluminum alloy extruded product that the aluminum alloy composition fall within the constraints of the present claims and that the alloy be extruded in the apparatus having the requirements set forth by the present claims. JP '353 not only does not disclose a composition falling within the scope of the present claims, it also does not show the apparatus limitations.

During the prosecution of the present application, the Examiner has stated that JP '353 discloses aluminum alloy compositions having a low iron content such as in Table 1, Examples 1-3 and 5-10, which would lead to the same lower corrosion resistance property achieved by the present invention. However, Samples 2, 3, 5-7, 9 and 10 have a high copper content and would have inferior corrosion properties. Samples 1 and 8 do not correspond to the presently claimed alloy composition because of the low silicon content. Since Samples 1 and 8 do not satisfy the claimed relationship of magnesium percent $\leq 1.7 \times$ silicon percent, these samples also have an inferior corrosion resistance. In JP '353, there is no disclosure regarding the influence of iron on corrosion resistance.

The Examiner has also pointed out that samples 2-7, 9 and 10 have a similar high strength as that of the claimed alloy. However, the high strength of samples 2-7, 9 and 10 is due to the extremely high copper content thereof. In these alloys, the copper content ranges from 3.5-5.8% as compared to the presently claimed alloy which has an upper limit copper content of 2.5%. The present invention achieves both a high corrosion resistance and high strength while having a

relatively low copper content by conducting the extrusion of the aluminum alloy under the claimed requirements. This clearly is not suggested by JP '353. As such, the secondary reference cited by the Examiner must provide the motivation to one of ordinary skill in the art to modify JP '353 in a manner that would yield the presently claimed invention. It is respectfully submitted that the secondary reference contains no such teachings.

JP '255 discloses an aluminum alloy billet having a composition comprising, by weight percent, 0.3-0.8% silicon, 0.7-1.3% magnesium, 0.1-0.5% copper, 0.05-0.7% iron, 0.05-0.2% manganese, 0.01-0.4% chromium, with the balance being aluminum and inevitable impurities. The billet is subjected to extrusion working by a flow guide 23 and a die 24 to produce a member for an automobile brake. The inner circumferential surface face 23a of the flow guide 23 is formed to be separated from the outer circumference of the orifice 24a of the die 24 by at least 20 mm to the circumference. The thickness of the flow guide 23 is controlled to 5-25% of the outer diameter of the flow guide 23 and extrusion working is performed at a product rate of 3-5 meters per minute. This reference has been cited by the Examiner as teaching substantially similar extrusion apparatus parameters as that of the present claims and, as such, obvious to use with the alloy composition disclosed in JP '353.

At the outset, Appellants wish to point out that the copper content of the alloy extruded in JP '255 is 0.1-0.5% as compared to 1.7-2.5% in the alloys in the present application and 1.5-6% in the alloys in JP '353. That is, the copper content in the alloy of JP '255 is less than the lower limit of 1.7% required in the present claims by 1.3%. This is clearly an unobvious difference and one of ordinary skill in the art of metallurgy would expect that the alloy of the present invention and the alloy disclosed in JP '255 would have very different properties.

The Examiner has stated that JP '255 discloses a flow guide similar to that of the presently claimed invention and that the apparatus limitations disclosed there are sufficiently close to that of the present invention in order to make the presently claimed invention obvious. Appellants respectfully disagree.

It has been stated that this reference discloses substantially similar extrusion apparatus parameters as that of the present invention including a thickness, T, of the product of from 50 to 100 mm and a bearing length of a solid die L approximately equal to T as shown in the diagrams. However, the diagrams are schematic and not drawn to scale. The Examiner cannot assume that a drawing or diagram is to scale when the specification or the description of the diagram is silent regarding the scale of the drawing or diagram.

It also has been stated that JP '255 shows a thickness of the product of from 50 to 100 mm in paragraphs [0018]-[0019]. Applicants can find no such disclosure. Although the diagram of the billet 31 in Figure 2 is not described, it would be approximately 200 mm if it has the same diameter as the outer diameter of the flow guide 23 in Figure 4. The size of the extruded product 32 is 100 mm × 15 mm and the ratio of the size between the billet and the extruded product is 200:50 ≈ 100 = 1:0.25 ≈ 0.5. Therefore, the assumptions regarding this reference appear to be incorrect and, even if they were correct, given the higher tensile and yield strengths associated with the presently claimed invention, the presently claimed invention would still be patentably distinguishable over the combination of JP '353 with JP '255.

With respect to the Examiner's assertion that JP '255 teaches a flow guide similar to that of the present claims and discloses apparatus limitations sufficiently similar to those of the present invention in order to make the presently claimed invention obvious, Appellants direct attention to the Declaration Under 37 CFR 1.132 executed on September 20, 2007 and of record in the present application in which an aluminum alloy having a composition falling within the scope of the

present claims is extruded. As shown in Table 2 in this Declaration, at a distance "A" of 4 mm, the aluminum alloy billet was extruded under an excessively high temperature which lead to recrystallization in the surface layer and prevented the material from obtaining a satisfactory strength. Due to the extruded product developing cracks, the intergranular corrosion test and the stress corrosion cracking test could not be performed. This is to be compared to a flow guide with a distance A of 5 mm up to a distance of 15 mm. At a distance "A" of 17 mm, when a successive billet was supplemented to a former billet for continuous extrusion, the end of the former billet was cut. That is, the end of the former billet was easy to deform and, as a result, when the successive billet was supplemented to the end of the former billet and was extruded, air tended to be captured where the two billets were joined, which lead to an increase in inferior parts of the product and decrease in yield rate. Applicants respectfully submit that this establishes the unobviousness of the presently claimed distance "A" of 5-15 mm. This test data is clearly closer to the presently claimed invention than any of the prior art cited by the Examiner since an alloy falling within the scope of the present claims was used in all of the tests with the only difference being the varying of the distance "A". Therefore, Appellants respectfully submit that not only does JP '353 in combination with JP '255 not make a showing of prima facie obviousness under 35 USC 103(a) with respect to the presently claimed invention, evidence is of record in the present application which is more than sufficient to rebut any proper rejection under 35 USC 103(a).

CLAIMS 11 AND 12 ARE SEPARATELY PATENTABLE
OVER JP '353 IN COMBINATION WITH JP '255

Claims 11 and 12 restrict the aluminum alloy to consisting of aluminum, 0.05-1.5% silicon, 0.9-1.6% magnesium, 1.7-2.5% copper, 0.5-1.2% manganese and, optionally, 0.02-0.4% chromium, 0.03-0.2% zirconium, 0.03-0.2% vanadium and 0.03-2.0% zinc. JP '353 and JP '255 both require that iron be present. That is, JP '353 requires that iron be present in an amount of from 0.1-0.5% and JP '255 requires that iron be

present in an amount of from 0.05-0.7%. In response to this difference, the Examiner has stated that iron is not an essential element in the prior art references and it would have been obvious to remove iron from these references with the corresponding omission of the function of iron. However, as shown in a second Declaration Under 37 CFR 1.132 dated December 22, 2008, the Examiner is in error.

In this second Declaration Under 37 CFR 1.132, the effect of iron on the anti-corrosive properties of the presently claimed aluminum alloy was investigated. Aluminum alloys were prepared with their iron composition in Alloy A where 0.1 wt.%, 0.2 wt.% in Alloy B and 0.4 wt.% in Alloy C. The alloys were extruded under identical conditions and the specimens evaluated by a measurement of the area fraction of a fibrous structure in the transverse cross-section, a tensile test and an intergranular corrosion test, which are shown in Table 2 in the Declaration. As shown in Table 2, Specimen 1 containing iron in an amount of 0.1 wt.% and Specimen 2 containing iron in an amount of 0.2 wt.% had an area ratio of fiber structure over 80%, good tensile properties and exhibited a corrosion weight loss of less than 1%, which confirmed that there was no problem with respect to corrosion resistance. On the other hand, the corrosion weight loss of Specimen 3, which contained iron in an amount of 0.4 wt.%, had a corrosion weight loss of 1.2% which markedly decreased the corrosion resistance of the aluminum alloy. This confirms that the Examiner's postulate regarding iron is incorrect and that iron content as an impurity does not have any influence on the corrosion resistance of the aluminum alloys but an iron content over 0.2% decreases the corrosion resistance. Therefore, currently presented Claims 11 and 12 are separately patentable over JP '353 combined with JP '255.

REJECTION OF CLAIMS 6, 9, 10, 12 AND 13
UNDER 35 USC 103(a) OVER JP '353 IN VIEW OF JP '255
AND FURTHER IN VIEW OF JP '897

Claim 6 is directed to the production of a hollow high-strength aluminum alloy extruded product using an aluminum alloy composition comprising, in percent by weight, 0.5-1.5%

silicon, 0.9-1.6% magnesium, 1.7-2.5% copper, while satisfying equations (1)-(4),

$$3 \leq Si\% + Mg\% + Cu\% \leq 4 \qquad (1)$$

$$Mg\% \leq 1.7 \times Si\% \qquad (2)$$

$$Mg\% + Si\% \leq 2.7 \qquad (3)$$

$$Cu\%/2 \leq Mg\% \leq (Cu\%/2) + 0.6 \qquad (4)$$

and further comprising 0.5-1.2% manganese with the balance being aluminum and unavoidable impurities. The billet is extruded into a hollow product by using a porthole die or a bridge die in which the ratio of the flow speed of the aluminum alloy in a non-joining section to the flow speed of the aluminum alloy in a joining section in a chamber, where the billet reunites after entering a port section of the die in divided flows and subsequently encircling a mandrel, is controlled at 1.5 or less, thereby obtaining a hollow product in which a fibrous structure accounts for 60% or more in area-fraction of the cross-sectional structure of the hollow product. JP '353 and JP '255 have been applied to Claim 6 and the claims dependent thereon in the same manner as discussed above in the previous rejection and the Examiner further posits that it would have been obvious to extrude the claimed aluminum alloy into a variety of configurations including hollow and solid sections. JP '897 has been cited as teaching an aluminum alloy with the compositional range overlapping the claimed compositional range which can be extruded in rectangular tubing for a bumper member. As such, the Examiner posits that it would have been obvious to extrude the presently claimed aluminum alloy into various configurations using a porthole die or a bridge die.

In response to these arguments, Applicants wish to point out that the copper content of JP '255 is 0.1-0.5%, the copper content of JP '353 is 1.5-6.0% and the copper content of JP '897 is 0.7-1.2%. Since the critical copper contents in these three references do not even overlap, Appellants respectfully submit that one of ordinary skill in the art of metallurgy would not expect that any teaching with respect to the alloy composition of either of the references could be

extended to the other. Moreover, none of these references specifically disclose the use of a porthole or bridge die. Therefore, satisfying the claimed relationship regarding the ratio of the flow speed of the aluminum alloy in a non-joining section to the flow speed of the aluminum alloy in a joining section would hardly be obvious. Although the Examiner has not cited a reference which shows the use of a porthole die or bridge die in extrusion, the Examiner argues that the range of speed of 1.5 or less includes 1, which means a condition of no speed change also satisfies the claimed condition. However, the Examiner has not made any showing which shows the flow conditions in a porthole die or a bridge die so there is no basis on which the Examiner can say that the claimed flow ratio would be obvious. As such, it is respectfully submitted that Claim 6 and the claims dependent thereon are patentably distinguishable over JP '353 in combination with JP '255 and JP '897.

CONCLUSION

For the reasons advanced above, it is respectfully submitted that the presently claimed invention is patentably distinguishable over the prior art cited by the Examiner. Reversal of the Examiner is respectfully solicited.

Respectfully submitted,

TFC/smd

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Encl: Claims Appendix
Evidence Appendix
Related Proceedings Appendix
Postal Card

CLAIMS APPENDIX

1. A method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance, the method comprising continuously extruding a billet of an aluminum alloy comprising, hereinafter, all compositional percentages are by weight, 0.5% to 1.5% of Si, 0.9% to 1.6% of Mg, 1.7% to 2.5% of Cu, while satisfying the following equations (1), (2), (3), and (4),

$$3 \leq Si\% + Mg\% + Cu\% \leq 4 \quad (1)$$

$$Mg\% \leq 1.7 \times Si\% \quad (2)$$

$$Mg\% + Si\% \leq 2.7 \quad (3)$$

$$Cu\%/2 \leq Mg\% \leq (Cu\%/2) + 0.6 \quad (4)$$

and further comprising 0.5% to 1.2% of Mn, with the balance being Al and unavoidable impurities, into a solid product by using a solid die having a bearing length (L) of 0.5 mm or more and the bearing length (L) and thickness (T) of the solid product to be extruded have a relationship defined by $L \leq 5T$, to obtain the solid product in which a fibrous structure accounts for 60% or more in area-fraction of the cross-sectional structure of the solid product, wherein a flow guide is provided in front of the solid die, an inner circumferential surface of a guide hole of the flow guide being separated from an outer circumferential surface of an orifice which is continuous with the bearing of the solid die at a distance of 5-15 mm, and the thickness of the flow guide being 5% to 25% of the diameter of the billet.

4. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 1, wherein the aluminum alloy further comprises at least one of 0.02% to 0.4% of Cr, 0.03% to 0.2% of Zr, 0.03% to 0.2% of V, and 0.03% to 2.0% of Zn.

5. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 1, the method additionally comprising a homogenization step wherein a billet of the aluminum alloy is homogenized at 450°C or more and cooled at an average cooling rate of 25°C/h or more from the homogenization temperature to at least 250°C, an extrusion step wherein the homogenized billet of the aluminum alloy is extruded at a temperature of 450°C or more, a press quenching step wherein the extruded product is cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more in a state in which the surface temperature of the extruded product immediately after the extrusion is maintained at 450°C or more, or a quenching step wherein the extruded product is subjected to a solution heat treatment at a temperature of 450°C or more and cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more, and an aging step wherein the quenched product is heated at a temperature of 150°C to 200°C for 2 to 24 hours.

6. A method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance, the method comprising the step of:

extruding a billet of an aluminum alloy comprising, in percent by weight, 0.5% to 1.5% of Si, 0.9% to 1.6% of Mg, 1.7% to 2.5% of Cu, while satisfying the following equations (1)-(4),

$$3 \leq Si\% + Mg\% + Cu\% \leq 4 \qquad (1)$$

$$Mg\% \leq 1.7 \times Si\% \qquad (2)$$

$$Mg\% + Si\% \leq 2.7 \qquad (3)$$

$$Cu\%/2 \leq Mg\% \leq (Cu\%/2) + 0.6 \qquad (4)$$

and further comprising 0.5% to 1.2% of Mn, with the balance being Al and unavoidable impurities, into a hollow product by using a porthole die or a bridge die in which the ratio of the flow speed of the aluminum alloy in a non-joining section to

the flow speed of the aluminum alloy in a joining section in a chamber, where the billet reunites after entering a port section of the die in divided flows and subsequently encircling a mandrel, is controlled at 1.5 or less, thereby obtaining the hollow product in which a fibrous structure accounts for 60% or more in area-fraction of the cross-sectional structure of the hollow product.

7. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to Claim 1, wherein L ≤ 3T.

8. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 4, the method additionally comprising a homogenization step wherein a billet of the aluminum alloy is homogenized at 450°C or more and cooled at an average cooling rate of 25°C/h or more from the homogenization temperature to at least 250°C, an extrusion step wherein the homogenized billet of the aluminum alloy is extruded at a temperature of 450°C or more, a press quenching step wherein the extruded product is cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more in a state in which the surface temperature of the extruded product immediately after the extrusion is maintained at 450°C or more, or a quenching step wherein the extruded product is subjected to a solution heat treatment at a temperature of 450°C or more and cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more, and an aging step wherein the quenched product is heated at a temperature of 150°C to 200°C for 2 to 24 hours.

9. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 6,

wherein the aluminum alloy further comprises at least one of 0.02% to 0.4% of Cr, 0.03% to 0.2% of Zr, 0.03% to 0.2% of V, and 0.03% to 2.0% of Zn.

10. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 6, the method additionally comprising a homogenization step wherein a billet of the aluminum alloy is homogenized at 450°C or more and cooled at an average cooling rate of 25°C/h or more from the homogenization temperature to at least 250°C, an extrusion step wherein the homogenized billet of the aluminum alloy is extruded at a temperature of 450°C or more, a press quenching step wherein the extruded product is cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more in a state in which the surface temperature of the extruded product immediately after the extrusion is maintained at 450°C or more, or a quenching step wherein the extruded product is subjected to a solution heat treatment at a temperature of 450°C or more and cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more, and an aging step wherein the quenched product is heated at a temperature of 150°C to 200°C for 2 to 24 hours.

11. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 1, wherein the aluminum alloy consists of Al, 0.05-1.5% of Si, 0.9-1.6% of Mg, 1.7-2.5% of Cu, 0.5-1.2% of Mn and, optionally, 0.02-0.4% Cr, 0.03-0.2% Zr, 0.03-0.2% V and 0.03-2.0% Zn.

12. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 6, wherein the aluminum alloy consists of Al, 0.05-1.5% of Si,

0.9-1.6% of Mg, 1.7-2.5% of Cu, 0.5-1.2% of Mn and, optionally, 0.02-0.4% Cr, 0.03-0.2% Zr, 0.03-0.2% V and 0.03-2.0% Zn.

13. The method of manufacturing a high-strength aluminum alloy extruded product excelling in corrosion resistance and stress corrosion cracking resistance according to claim 9, the method additionally comprising a homogenization step wherein a billet of the aluminum alloy is homogenized at 450°C or more and cooled at an average cooling rate of 25°C/h or more from the homogenization temperature to at least 250°C, an extrusion step wherein the homogenized billet of the aluminum alloy is extruded at a temperature of 450°C or more, a press quenching step wherein the extruded product is cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more in a state in which the surface temperature of the extruded product immediately after the extrusion is maintained at 450°C or more, or a quenching step wherein the extruded product is subjected to a solution heat treatment at a temperature of 450°C or more and cooled to a temperature of 100°C or less at a cooling rate of 10°C/sec or more, and an aging step wherein the quenched product is heated at a temperature of 150°C to 200°C for 2 to 24 hours.

EVIDENCE APPENDIX

Declaration Under 37 CFR 1.132 dated September 20, 2007

Declaration Under 37 CFR 1.132 dated December 22, 2008

PATENT APPLICATION

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicants: Hideo SANO et al

For: METHOD OF MANUFACTURING HIGH-STRENGTH ALUMINUM ALLOY EXTRUDED PRODUCT EXCELLING IN CORROSION RESISTANCE AND STRESS CORROSION CRACKING RESISTANCE

Serial No.: 10/666 216 Group: 1793

Confirmation No.: 8302

Filed: September 18, 2003 Examiner: Yang

Atty. Docket No.: 3796.P0042US

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 CFR 1.132

I, Hideo SANO, hereby declare as follows:

I am one of the inventors of the invention described and claimed in application Serial No. 10/666 216, filed on September 18, 2003.

I hereby incorporate by reference herein the contents of the Examples and Comparative Examples contained in application Serial No. 10/666 216 and the 37 CFR 1.132 Declaration executed by me on September 20, 2007.

I have performed additional test data that illustrates that the presence of iron reduces the corrosion resistance in the aluminum alloy extruded products of the present invention.

Aluminum alloys having the compositions shown in Table 1 below were prepared.

Table 1

Alloy	Composition (wt%)					
	Si	Fe	Mg	Cu	Mn	Cr
A	0.9	0.1	1.0	1.7	0.8	0.2
B	0.9	0.2	1.0	1.7	0.8	0.2
C	0.9	0.4	1.0	1.7	0.8	0.2

Aluminum alloys A, B and C were cast by semi-continuous casting to prepare billets with a diameter of 100mm. The billets were homogenized at 530°C for 8 hours, and cooled from 530° to 250°C at an average cooling rate of 250°C/h to prepare extrusion billets.

The extrusion billets were heated to 520°C and extruded by using a solid die at an extrusion ratio of 27 and an extrusion speed of 6m/min to obtain a solid extruded product having a rectangular profile of 12mm thickness by 24mm width. The solid die had a bearing length of 6mm and the corners of its orifice were rounded off with a radius of 0.5mm. A flow guide attached to the die had a rectangular guide hole with a distance (A) from the inner circumferential surface of the guide hole to the outer circumferential surface of the orifice set at 12mm, and a thickness (B) of the flow guide set at 15mm with respect to the billet diameter of 100mm (B=15% of the billet diameter).

The solid extruded products thus obtained were subjected to a solution heat treatment at 540°C, and to a water quenching treatment within 10 seconds of the solution heat treatment. After 8 days from completion of the quenching, an artificial ageing (tempering) was provided at 175°C for 8 hours to refine the quenched product to T6 temper.

T6 materials (specimens) were evaluated by (1) a measurement of the area ratio of a fibrous structure in the transverse cross-section, (2) a tensile test, and (3) an intergranular corrosion test described below.

(1) Measurement of area ratio of fibrous structure: The area ratio of a fibrous structure in the transverse cross section was measured by using image analysis equipment and its ratio (%) to the total area was calculated.

(2) Tensile test: Each specimen was tested in accordance with JIS Z2241 for ultimate tensile strength (UTS), yield strength (YS), and facture elongation (δ).

(3) Intergranular corrosion test: A test solution was prepared by dissolving 57 grams of sodium chloride (NaCl) and

10 ml of 30% aqueous hydrogen peroxide (H_2O_2) into distilled water to make a total of 1 liter solution. Each specimen was immersed in the test solution at 30°C for 6 hours, and the corrosion weight loss was measured. A specimen showing a weight loss of less than 1.0% was judged as having good corrosion resistance. The evaluation is same as that of the Examples in the specification of the present invention.

The evaluation results are summarized in Table 2.

Table 2

Specimen	Alloy	Area ratio of fibrous structure (%)	UTS (MPa)	YS (MPa)	δ (%)	Corrosion weight loss (%)
1	A	82	441	403	12	0.4
2	B	83	442	405	11	0.6
3	C	83	438	402	12	1.2

DISCUSSION OF RESULTS

As shown in Table 2, the specimen 1 containing Fe:0:1% and the specimen containing Fe:0.2% had Area ratio of fibrous structure over 80% and were provided with good tensile property. The specimens 1 and 2 showed Corrosion weight loss of less than 1.0%, and it was confirmed that there is no problem of corrosion resistance. On the other hand, Corrosion weight loss of the specimen containing Fe:0.4% over 0.2% was 1.2%, and it was found that there was problem of corrosion resistance. As a result, it is confirmed that Fe content as impurity does not have any influence on corrosion resistance, but Fe content over 0.2% decreases corrosion resistance. That is, the aluminum alloy extruded product of the present invention containing Fe only as impurity has no problem of corrosion resistance, but the aluminum alloy extruded product of JP '358 in which Fe is essential alloying element, has a problem of corrosion resistance.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that

willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: December 22, 2008

Hideo Sano

Hideo SANO

PATENT APPLICATION

IN THE U.S. PATENT AND TRADEMARK OFFICE

September 12, 2007

Applicants: Hideo SANO et al

For: METHOD OF MANUFACTURING HIGH-STRENGTH ALUMINUM ALLOY EXTRUDED PRODUCT EXCELLING IN CORROSION RESISTANCE AND STRESS CORROSION CRACKING RESISTANCE

Serial No.: 10/666 216 Group: 1742

Confirmation No.: 8302

Filed: September 18, 2003 Examiner: Morillo

Atty. Docket No.: 3796.P0042US

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 CFR 1.132

I, the undersigned, hereby declare as follows:

I am one of the inventors of the invention described and claimed in application Serial No. 10/666 216, filed on September 18, 2003.

I hereby incorporate by reference herein the contents of the Examples and Comparative Examples contained in application Serial No. 10/666 216.

I have performed additional tests to illustrate the criticality of the inner circumferential surface of the guide hole of the flow guide being separated from an outer circumferential surface of an orifice which is continuous with the bearing of the solid die at a distance of 9-15mm.

TEST PROCEDURE

An aluminum alloy having the composition shown in the below Table 1 was cast by semi-continuous casting to prepare billets with a diameter of 100 mm. The billets were homogenized at 530°C for 8 hours and cooled from 530°C to 250°C at an average cooling rate of 250°C/h to prepare extrusion billets.

Table 1

Alloy Composition (mass%)					
Si	Mg	Cu	Mn	Cr	Al & Impurities
0.9	1.0	1.7	0.8	0.2	Bal

The extrusion billets were heated at 520°C and extruded by using a solid die at an extrusion ratio of 27 and an extrusion speed of 6 m/min to obtain solid extruded products having a rectangular profile of 12 mm thickness by 24 mm width. The solid die had a bearing length of 6 mm and the corners of its orifice were rounded off with a radius of 0.5 mm. A flow guide attached to the die had a rectangular guide hole with a distance (A) from the inner circumferential surface of the guide hole to the outer circumferential surface of the orifice set at 4 mm, 5 mm, 9 mm, 12 mm, 15 mm and 17 mm, respectively, and a thickness (B) of the flow guide set at 15 mm with respect to the billet diameter of 100 mm. (B=15% of the billet diameter). The solid extruded products obtained were solution treated at 540°C, and water-quenched within 10 seconds after the solution heat treatment. After 3 (three) days after completion of the quenching, an artificial aging (tempering) at 175°C for 8 hours was made to refine the quenched products to T6 temper condition.

TEST RESULTS

The properties of the T6 temper material obtained were evaluated by (1) a measurement of properties of the area ration of a fiber structure in the transverse cross section, (2) a tensile test, (3) an intergranular corrosion test and (4) a stress corrosion cracking test mentioned below. The test results are summarized in Table 2.

(1) Measurement of area ratio of fiber structure: The area of a fiber structure in the transverse cross

section was measured by using an image analyzer and its ratio (%) to the total area was calculated.

(2) Tesile test: Ultimate tensile strength (UTS), yield strength (YS) and elongation (δ) were measured in accordance with JIS Z 2241.

(3) Intergranular corrosion test: A test solution was prepared by dissolving 57 grams of sodium chloride (NaCl) and 10 ml of 30% aqueous hydrogen peroxide (H_2O_2) into distilled water to make a total of 1 liter solution. Each specimen was immersed in the test solution at 30°C for 6 hours, and the corrosion weight loss was measured. A specimen showing a weight loss of less than 1.0% was judged as having good corrosion resistance.

(4) Stress corrosion cracking test: Based on the test specified in JIS H 8711 using a C-ring test piece (28 mm in diameter, 2.2 mm in thickness), the time to fracture at a stress of 350 MPa was measured. A specimen showing no cracking at 700 hours was judged as having good stress corrosion cracking resistance.

Table 2

Specimen	A (mm)	Area ratio of fiber structure (%)	UTS (MPa)	YS (MPa)	δ (%)	Corrosion weight loss (%)	Stress corrosion cracking time (h)
1	4	54	280	160	5	--	--
2	5	62	405	365	10	0.8	>700
3	9	70	430	385	11	0.6	>700
4	12	82	440	405	12	0.4	>700
5	15	90	445	408	12	0.3	>700
6	17	92	448	414	13	0.3	>700

DISCUSSION OF RESULTS

Specimen 1 was extruded using a flow guide with an insufficient dimension for the distance A. As a result, the

aluminum alloy billet was extruded under an excessively high temperature and it led to recrystallization in the surface layer which prevented the material from obtaining satisfactory strength. Since the extruded product developed cracks, the intergranular corrosion test and the stress corrosion cracking test could not be performed.

Specimen 2 was extruded using a flow guide with a distance A of 5 mm. An extruded product with a fiberous structure of 62% in area-fraction of the cross-sectional structure was obtained. It had a good strength, corrosion resistance and stress corrosion cracking resistance.

Specimen 3 was extruded using a flow guide with the distance A of 9 mm and an extruded product with an increased area-fraction (70%) of a fiberous structure was obtained. It had an excellent strength, corrosion resistance and stress corrosion cracking resistance in comparison with Specimen 2.

Specimen 4-6 were extruded using flow guides with a distance A of 12 mm, 15 mm and 17 mm, respectively. The extruded products had a further increased area-fraction (82%, 90% and 92%, respectively) of a fiberous structure and more excellent strength, elongation and corrosion resistance in comparison with Specimen 3.

As mentioned above, it has been proved that:

By using a flow guide with the distance A of 5 mm or more, which is the distance between the inner circumferential surface of the guide hole inside the flow guide at the front of the solid die and the outer circumferential surface of the orifice of the solid die, an extruded product with a fiberous structure of 60% or more in area-fraction of the cross-sectional structure of the product was obtained which led to a good strength, corrosion resistance and stress corrosion cracking resistance of the extruded product.

By using flow guides with a distance A of 9-17 mm, the extruded products had further an increased area-fraction (70%-92%) of fiberous structure, which led to an excellent strength, elongation and corrosion resistance in comparison

with using a flow guide with a distance A of 5 mm, together with an excellent stress corrosion cracking resistance.

It was also confirmed that when a flow guide with a distance A over 15 mm, for example 17 mm, was used, there was the following problem. When a successive billet was supplemented to a former billet for a continuous extrusion, the end of the former billet was cut. In this case, the end of the former billet was easy to deform. As a result, when the successive billet was supplemented to the end of the former billet and was extruded, air tended to be captured where the two billets were joined, which led to an increase in inferior parts of the product and decrease of yield rate. Therefore, it is preferable that the distance of A is 9-15 mm.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: September 20, 2007 Hideo Sano

110.0703

RELATED PROCEEDINGS APPENDIX

There are no related proceedings.